Mechanisms for Characterizing Deep-Sea Coral Biodiversity

Expedition: Discovering Deep-Sea Corals of the Phoenix Islands 2

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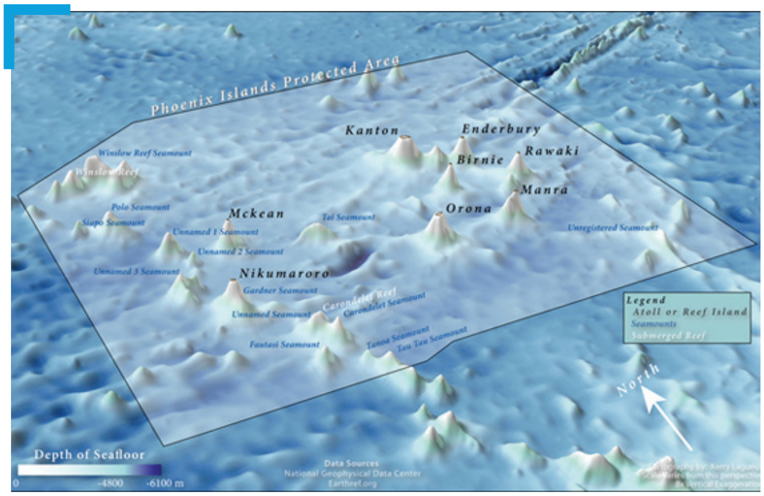
The ocean is home to vast amounts of biodiversity from surface waters to the deepest depths, which extend more than 10,000 meters (33,000 feet) below the surface. The warm, shallow waters near the equator in the Pacific Ocean are among the most diverse coral hotspots in the world. On this expedition, one of our objectives was to describe biodiversity between shallow and deep ocean waters in that area. We explored from 100 meters (328 feet) down to 3,000 meters (nearly 10,000 feet) in the Phoenix Archipelago, a small group of islands and seamounts in the central Pacific.



Map of the network of islands, atolls, seamounts, and submerged reefs that make up the Phoenix Islands Protected Area (PIPA) [8X vertical exaggeration]. Though PIPA is one of the most explored areas in the Pacific, with past expeditions with R/V *Falkor*, E/V *Nautilus*, and NOAA Ship *Okeanos Explorer*, there is still a lot to learn about biodiversity in the region. *Map courtesy of Kerry Lagueux/SOI.*

Building on the Past

Our team first explored the Phoenix Islands Protected Area (PIPA) during a 2017 cruise. Video footage from this cruise was analyzed back on land, and used to distinguish 167 species of deep-sea corals. However, we could only fully identify about a quarter of those species by comparing high-resolution images and collected specimens from this cruise to known records. We lacked enough information to fully identify the rest. Still, our discoveries allowed for new species descriptions and depth ranges for many of those species. During our return to the area in 2021, we added to those discoveries with more coral specimens collected from sites north of the Phoenix Islands Protected Area.

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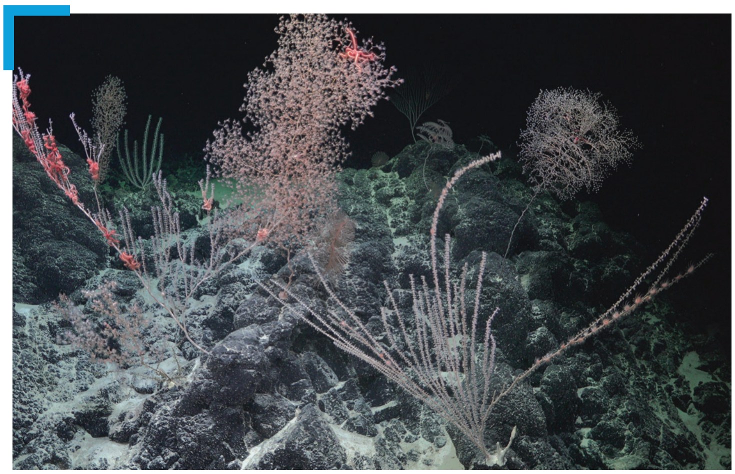
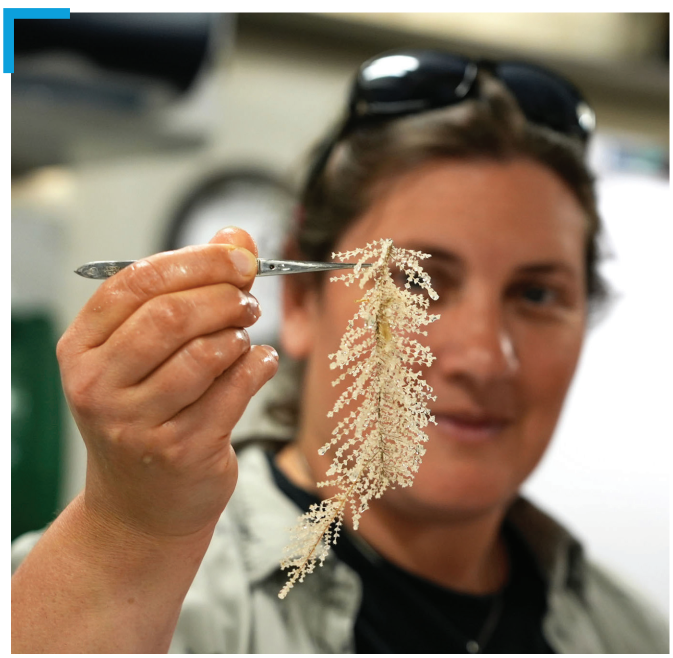
Seamounts are mountains found in the ocean, generally formed by extinct volcanoes. Studies indicate that they function as 'oases of life,' with higher species diversity and biomass than on surrounding areas of sea floor.
https://oceanexplorer.noaa.gov/facts/seamounts.html



Diverse deep-sea coral communities observed on a seamount during one of the ROV dives. *Image courtesy of SOI/ROV SuBastian.*



Chief scientist Randi Rotjan holds a sample of *Thourella* coral collected during a dive of the ROV *SuBastian*. *Image courtesy of SOI/Erik Olsen.*

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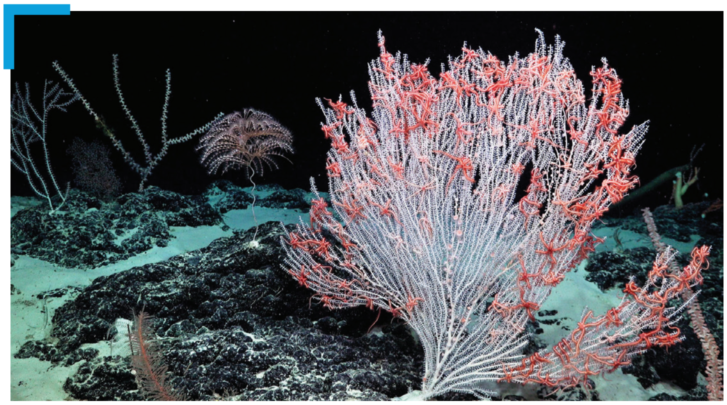
Water Under Water

One major finding from this more recent cruise is how strong the influence of local ocean conditions is on deep-sea coral biodiversity in the equatorial central Pacific. Specifically, we identified the strong effects that deep ocean water masses have on deep-water coral communities between 200—2,600 meters (656—8,500 feet). In this area, our team found three distinct **water masses**, each with their own unique temperature, salinity, and dissolved oxygen concentrations. These water masses appeared to directly impact where some coral species were found. Species found in shallower areas less than 600 meters (2,000 feet) deep were more likely to occupy narrow depth ranges, while coral species found in deeper water occupied wider depth ranges.

Many other variables are also responsible for observed patterns of biodiversity. These include variations in food supply, predation, reproduction, and dispersal. Additionally, the dynamic forces of currents around seamounts have an impact on where organisms are found.



A ghostly primnoid coral is covered in brittle stars that use the corals' structure to gather nutrients from the water currents. An *Iridigorgia* and bamboo corals can be seen in the background. *Image courtesy of SOI/ROV SuBastian.*

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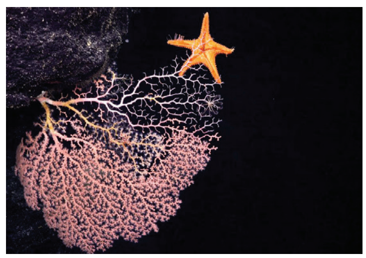
Water masses are layers of the ocean with similar temperature, salinity (amount of salt), or dissolved oxygen concentrations.

Searching Via eDNA

It is not always possible to completely describe a site due to time and sampling capacity limitations. New technologies help increase our effectiveness. In this expedition, we applied new environmental DNA (eDNA) techniques. For this method, we collected seawater from around the deep-sea corals and brought it back to the lab. There, we filtered the water, looking for DNA contained in the mucus that the corals shed off into the water. Then, we preserved the DNA for later sequencing. After sequencing this eDNA sample, we will compare it to DNA sequences in a known library of DNA barcodes from specimens collected in 2017 and 2019 in order to identify the species present in the area.

The goal of developing this new method is to allow us to describe the deep sea and the organisms that live there more efficiently. eDNA techniques are more cost- and time-efficient than other identification methods and they reduce our need to sample long-lived and sensitive deep-sea organisms invasively.



On the first ROV dive, researchers saw this striking and clear example of corallivory: a predator eating coral mucus, tissue, and even skeleton of a coral. Here a corallivorous deep-sea sea star *Evoplosoma* eats live coral at a depth of 2,004 meters (6,500 feet). *Image courtesy of SOI/ROV SuBastian.*

The vacuum filtration unit used to filter eDNA from sea water samples collected by ROV *SuBastian*. *Image courtesy of SOI/ Monika Naranjo Gonzalez.*

An undergraduate student works in R/V *Falkor's* wet lab, preparing and studying biological samples like the eDNA water samples collected during the ROV dives. *Image courtesy of Erik Olsen/SOI.*

Original cruise log: https://schmidtocean.org/cruise-log-post/mechanisms-for-characterizing-deep-sea-coral-biodiversity/
Expedition: https://schmidtocean.org/cruise-log-post/mechanisms-for-characterizing-deep-sea-coral-biodiversity/
Explorer (bio): https://schmidtocean.org/person/steve-auscavitch/
Phoenix Islands Protected Area (image): https://schmidtocean.org/wp-content/uploads/3dPerspective_wSeamounts_11-19-08.jpg
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Primnoid coral (image): https://schmidtocean.org/wp-content/uploads/FK210605-Dive421-white_coral_fan_stars.jpg
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Wet lab (image): https://schmidtocean.org/wp-content/uploads/Anameere_Tennaba-Wetlab-2.jpg

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